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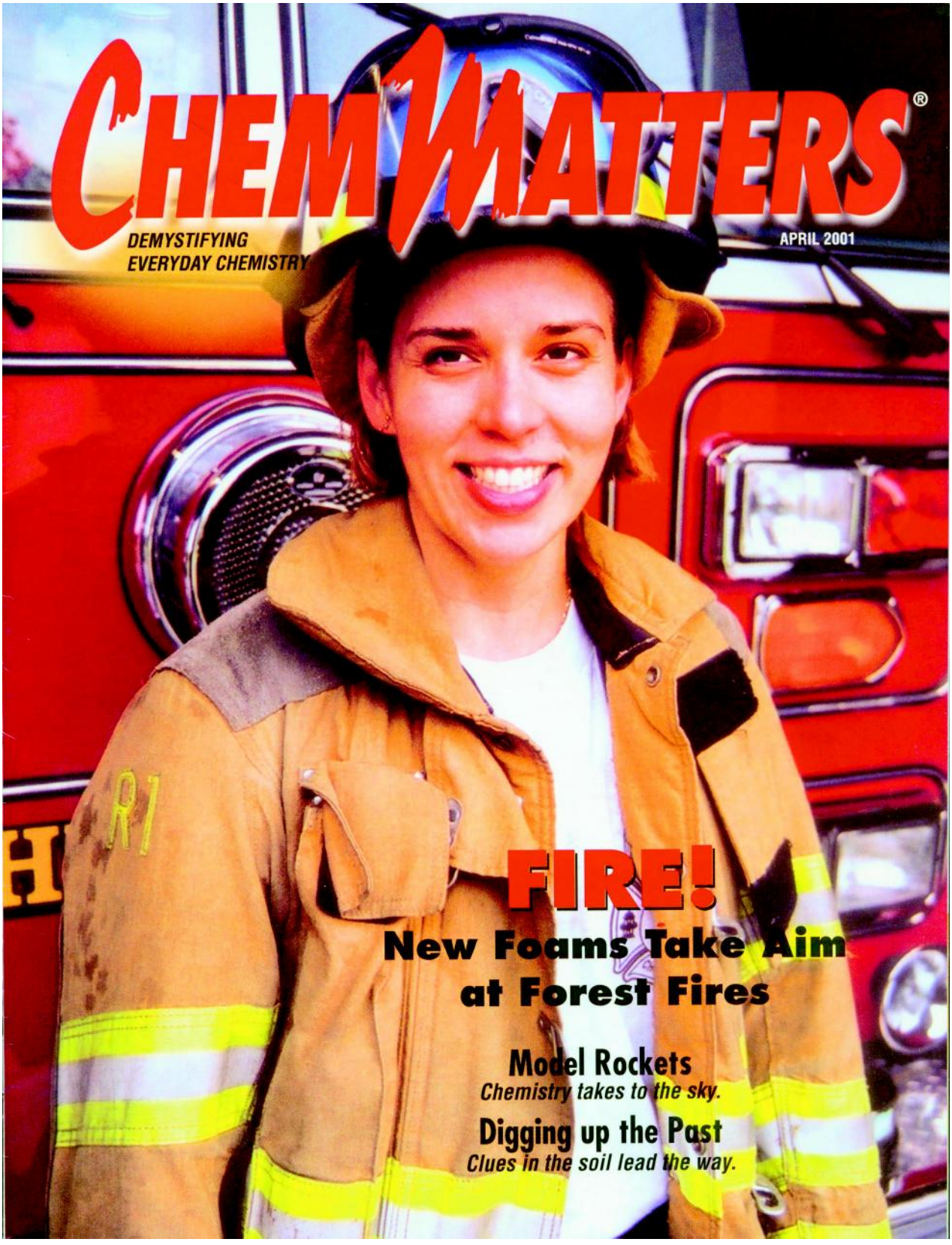

Chemical Foams in the Line of Fire

By Myrna Zelaya-Quesada

"I could see the big fireball rolling across the sky from treetop to treetop, and the winds it created just roared like a tornado." Retired Deputy Chief Jim Tuma was describing his unforgettable first-hand experience fighting the wildfire that burned 450 acres of the dense ponderosa pine forest near Los Alamos, NM, in May 2000.

Most of us who watched the scene on TV saw acres of trees blazing like candles on a cake. And many lamented the loss of a forest of pines, once stretching 60–80 ft into the sky with trunks that could not be contained in a hug.

While most forest fires begin accidentally, this fire began with a routine "controlled burn" that shortly became anything but that. Starting a fire intentionally sounds foolhardy, but burning is actually a commonly used forest management technique for clearing underbrush. In some locations, burning requires more careful control than in others. Los Alamos, where 60-mph winds can blow among the trees in topsy-turvy directions, is an area where burning is particularly risky.

Feeding a fire

"To exist, a fire needs three things—heat, oxygen, and fuel," states Tuma. Once ignition occurs, the rapid winds wick the flames from treetop to treetop. Errant sparks fly through the air landing on lower branches and underbrush for rapid ignition. As more and more of the forest burns, the increase in temperature agitates the air into convection currents of almost 100 mph, the Deputy Chief explained. When the whole forest becomes inflamed, temperatures may reach several thousand degrees Fahrenheit. If water boils at a mere 212 degrees, how can a forest fire be stopped?

Understanding how fires thrive helps firefighters to design strategies for controlling them. To put out a fire, they need to remove at least one of the elements that feed it. Imagine going on a camping trip and building a fire. As a responsible camper, you extinguish the fire upon leaving, generally by applying water and shovels of dirt to the flames. Why is this effective? The rapidly evaporating water cools the area, dropping the temperature—no heat, no fire. Water soaks the wood, making it less flammable to the next spark. Before wet wood can burn, heat energy must first supply enough energy to vaporize the water. And with your shovelful of dirt, you create a barrier that prevents oxygen from reaching any potentially burnable material remaining in the campfire area.

In fact, until recently, water and dirt remained the predominant means of controlling a blaze. But many blazes prove to be too great for this simple strategy. Forest fires, like those in Los Alamos, are particularly difficult to control because their main source of fuel is pine. "Pine needles catch on fire so easily it's like miniature explosions," said Deputy Chief Frank Geigler of the Bethesda–Chevy Chase Rescue Squad in Maryland. "You ever see a Christmas tree catch on fire? It goes like that," he said, snapping his fingers. Pine needles greatly increase the flammable surface area of these trees, making ideal tinder for rapid ignition.

When the whole forest becomes inflamed, temperatures may reach several thousand degrees Fahrenheit. Traditional fire-fighting weapons like water and soil just can't do the job.

PHOTO FROM ACS STOCK PHOTOGRAPHS

The foam solution

Additives can be combined with water to make it more effective for extinguishing flames. Some of these additives are foam solutions, first used by firefighters in 1928. Some ingredients in foams raise the boiling point of water, making it more effective in combating large blazes. Firefighting foams penetrate flames, spreading over them like a shield. They extinguish fires by removing the heat from the fuel source and blocking its access to oxygen.

Appearing frothy and fairly solid, foams are actually *aerated liquids*—liquids combined with air. As liquids, they cool the area they cover. As millions of frothy bubbles, they act like a blanket, preventing fuel vapors from escaping into the air while preventing oxygen in the air from feeding remaining flames.

Over the past 72 years, hundreds of fire-fighting foams have been developed from a wide variety of sources. There are even protein foams made from hooves and fish and meal—effective but smelly.

Fire fighting goes green

The newest members of the fire-fighting foam team are "green foams", so-called because they are more biodegradable than all the rest. Why is this important? Many of the substances that cause the most hard-to-combat fires are not only flammable, but also poisonous in the environment. They destroy the microorganisms in the soil, preventing the decomposition of organic matter, a crucial step in maintaining a balanced ecosystem.

The responsibility of fire stations is not only to put out a fire, but also to make sure that the fuels that started it do not reignite or contaminate the groundwater. But of equal importance is making sure that the chemicals used to fight the fires do no environmental harm of their own. Nature can eventually break down the components in fire-fighting foams. However, if their concentration is too high, soil organisms may not be up to the task.

"Is it bad?" asked Kenny Plunkett, a senior firefighter with a Hazmat station in Chevy Chase, MD, when I asked if fuel and foam could be dangerous to the environment. "We got called in to investigate a creek up in Rockville where the fish were belly up. The neighbors were complaining of a smell of gasoline. We found out that a car had caught on fire and an aqueous film-forming foam (AFFF) had been used. Somehow, runoff ended up in the creek. You tell me."

PHOTO COURTESY OF PYROCOOL TECHNOLOGIES, INC.

Pyrocool Fire Extinguishing Foam smothers flames and leaves residues that soil bacteria can digest.

"If foam is being used, we need to be there." He showed me large drums for storing vacuumed debris to be used in combination with huge bags of different absorbents. Some looked like mixes of kitty litter and dust bunnies from under the bed.

I learned that paper absorbents can be laid over water to pick up floating fuel and foam. The "kitty litter" is used on the ground or on roads. Everything is shoveled, scooped, or suctioned into drums for disposal.

Green foams are classified as the most biofriendly foams on the market. Currently, the National Fire Protection Association is working on developing standards or guidelines to be met for fire-fighting foams used across the country. Many standards are already in effect.

Last year, *ChemMatters* reported on Pyrocool fire-fighting foam as a winner of the President's Green Chemistry Award (See "Green Chemistry—Benign by Design" in December 1999 *ChemMatters*). In the spring of 2000, Pyrocool Technologies, Inc., donated supplies of the foam for use against the fires threatening a Pueblo Indian Reservation near Los Alamos. Mirco-Blaze Out, a biofriendly foam manufactured by Verde Environmental, Inc., was also donated to fight the fires in Los Alamos. This unique foam is the only one on the market partially composed of live organisms. Wayne Fellers of Micro-Blaze Out explains that the foam is filled with bacterial spores—bacteria in an inactive state encased within resistant cell walls. The bacteria need only water and nutrients to become active. When the foam concentrate is combined with water, the bacterial spores break open, and growth begins. The foam partially protects the bacteria from the heat of the fire while depositing them onto the fuel. The foam acts to cool the fuel and stop the flames from reforming. With the flames gone, surviving bacteria go to work, eating up the remaining fuel.

Firefighters nationwide are working at teaching the public how to protect themselves and the areas in which they live from fires. Just as new fire-fighting foams are constantly being developed for this purpose, perhaps the future will also see foams that help reestablish life in areas left sterile by natural and human-made fires.

PHOTO COURTESY OF HENRIK G. DE GYOR

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REFERENCE

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